MILITARY SPECIFICATION

TRANSISTOR, PNP, SILICON
TYPE 2N2377

1. SCOPE

1.1 Scope.- This specification covers the detail requirements for silicon, PNP, transistors for use in audio-and radio-frequency amplifier circuitry.

1.2 Outline and dimensions.- (See Figure 1.)

1.3 Particular electrical characteristics.- At T_A = + 25° ± 3°C. (See 3.2.):

	C_{ob} (at: f = 4 mc V_{CB} = -6 Vdc I_E = 1 mAdc)	h_{fe} (at: V_{CE} = -6 Vdc I_E = 1 mAdc: f = 1 kc)	$f_{(max)}$ (at: V_{CB} = -6 Vdc I_E = 1 mAdc)	$r_b' C_c$ (at: f = 10 mc V_{CB} = -6 Vdc I_E = 1 mAdc)
	pf	—	mc	psec
Minimum	—	15	8	—
Maximum	12	—	—	5,000

1.4 Absolute Maximum ratings.- At T_A=25°C, unless otherwise specified. (See 3.2 herein):

P_T 1/	V_{CB}	V_{CE}	V_{EB}	T_{stg}	Altitude 2/
mW	Vdc	Vdc	Vdc	°C	ft
150	-25	-25	-10	-65 to + 140	85,000

1/ For power dissipation at T_A > + 25°C, derate at 1.33 mW/°C.

2/ Without voltage derating.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-S-19500 Semiconductor Devices, General Specification For

STANDARDS

MILITARY

MIL-STD-750 Test Methods For Semiconductor Devices

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both the title and number or symbol should be stipulated when requesting copies).

3. REQUIREMENTS

3.1 Requirements. - Requirements for the transistors shall be in accordance with Specification MIL-S-19500, and as specified herein.

3.2 Abbreviations and symbols. - The abbreviations and symbols used herein are defined in Specification MIL-S-19500, and as follows:

P_T ..... total power dissipation of the device: sum of collector and emitter power dissipations = $(V_{CB}\ I_C) + (V_{EB}\ I_E)$

$r_b' C_c$ ... extrinsic base-resistance collector-capacitance product

3.3 Design and construction. - The transistor shall be of the design, construction, and physical dimensions specified on Figure 1.

3.3.1 Operating position. - The transistors shall be capable of proper operation in any position.

3.3.2 Lead arrangement. - The lead arrangement on the transistors shall be as indicated in Figure 1.

3.4 Performance characteristics. - The transistor performance characteristics shall be as specified in Tables I, II, and III.

3.5 Marking.- The transistor shall be marked in accordance with Specification MIL-S-19500 and as follows. When the diminutive size or lack of suitable surface area prevents routine marking, on the device, of all items required by Specification MIL-S-19500, the following items may be omitted in the following preferred order: color-band type identification (if specified for the device), country of origin, manufacturer's identification. Where only a minimum of items can suitably be marked on the device, first consideration shall be given to marking the complete type designation (see 3.5.1), and then to inclusion of the acceptance date and inspection lot identification. However, all required marking shall be placed on the unit package.

3.5.1 Complete type-designation marking.- Complete type-designation marking of transistors procured on Department of Army contracts, and which have passed Government inspection and comply with all requirements of this specification, shall consist of: "USA-manufacturer's qualification code letters-transistor designation (including any assigned reliability indicator)." The letters "JAN" or any abbreviation thereof shall not be used. If any specification waiver has been granted, the combination "USA-manufacturer's qualification code letters" shall not be used to complete the type-designation marking.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- Except as otherwise specified herein, the responsibility for inspection, general procedures for acceptance, classification of inspection, and inspection conditions and methods of test shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions.

4.1.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Qualification and Acceptance Inspection.- Qualification and Acceptance Inspection shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions, and as otherwise specified herein. Groups A, B, and C inspection shall consist of the examinations and tests specified in Tables I, II, and III respectively. Group C inspection shall be conducted on the initial lot and thereafter on a lot approximately every 90 days or every fifth lot, whichever occurs first. Acceptance Inspection shall include inspection of Preparation for Delivery. (See 5.1.)

4.2.1 Specified LTPD for subgroups. - The LTPD specified for a subgroup in Tables I, II, and III shall apply for all of the tests, combined, in the subgroup. (See 6.3.)

4.2.2 Disposition of sample units. - Sample units subjected to Group B, Subgroup 4 and 5, inspection shall not be delivered on the contract or order. Sample units that have been subjected to and have passed Group B, Subgroups 1, 2, 3, 6 and 7 tests, and Group C, subgroup 1 tests, may be delivered on the contract or order provided that, after Group B and C inspection is terminated, those sample units are subjected to and pass Group A inspection. Defective units from any sample group that may have passed group inspection shall not be delivered on the contract or order until the defect(s) has been remedied to the satisfaction of the Government.

4.3 Particular examination and test requirements. -

4.3.1 Test temperature. - All electrical test measurements shall be made at room ambient temperature of + 25° ± 3°C unless otherwise specified herein.

4.3.2 Interval for end-point test measurements. - All applicable end-point test measurements shall be made within four (4) hours after the particular sample units have been subjected to the required physical-mechanical or environmental test. This "interval" requirement shall not be applicable to measurements specified to be made during (subjection of sample units to) a physical-mechanical or environmental test, and shall not be applicable where otherwise specified for life test(s).

4.3.3 Mechanical damage resulting from tests. - Except for intentionally deforming, mutilating, or dismembering mechanical-stress tests to which samples are subjected, there shall be no evidence of mechanical damage to any sample unit after any of the Group A, B, or C tests.

Table I. Group A inspection.

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD	Symbol	Limits Min	Limits Max	Unit
	Subgroup 1		10				
2071	Visual and mechanical examination	---		---	---	---	---
	Subgroup 2		5				
3011	Collector-to-emitter breakdown voltage	Bias Cond. D I_C = -25 uAdc I_B = 0		BV_{CEO}	-25	---	Vdc
3061	Emitter-to-base cutoff current	Bias Cond. D V_{EB} = -10 Vdc I_C = 0		I_{EBO}	---	-0.1	uAdc
3036	Collector-to-base cutoff current	Bias Cond. D V_{CB} = -25 Vdc I_E = 0		I_{CBO}	---	-1.0	uAdc
3076	Static forward-current transfer ratio	V_{CE} = -0.5 Vdc I_C = -5 mAdc		h_{FE}	10	---	---
	Subgroup 3		5				
3206	Small-signal short-circuit forward-current transfer ratio	V_{CE} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{fe}	15	---	---
---	Extreme base-resistance collector-capacitance product	V_{CB} = -6 Vdc I_E = -1 mAdc f = 10 mc Test circuit per Fig. 2 herein		$r_b'C_c$	---	5,000	psec
3236	Output capacitance	V_{CB} = -6 Vdc I_E = 1 mAdc f = 4 mc		C_{ob}	---	12	pf
3201	Small-signal short-circuit input impedance	V_{CB} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{ib}	---	90	ohms

Table I. Group A inspection. -(Continued)

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD	Symbol	Limits Min	Limits Max	Unit
	Subgroup 3 -(Cont'd)						
3216	Small-signal open-circuit output admittance	V_{CB} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{ob}	---	2.5	umhos
3311	Maximum frequency of oscillation	V_{CB} = -6 Vdc I_E = 1 mAdc Test circuit per Fig. 3 herein		$f_{(max)}$	8	---	mc
	Subgroup 4 1/		15				
2/	High-temperature operation:	T_A = + 125°C, min					
3036	Collector-to-base cutoff current	Bias Cond. D V_{CB} = -25 Vdc I_E = 0		I_{CBO}	---	-25	uAdc
2/	Low-temperature operation:	$T_A = -55° \, {}^{+0°}_{-3°}C$					
3206	Small-signal short-circuit forward- current transfer ratio	V_{CE} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{fe}	10	---	---

1/ For this Subgroup, the sample units subjected to the High-Temperature Operation test shall be allowed to return to and be stabilized at room ambient temperature prior to their being subjected to the Low Temperature Operation test.

2/ Test measurement shall be made at the temperature specified after the sampling units have reached thermal equilibrium at that temperature.

Table II. Group B inspection.

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits Min	Limits Max	Unit
	Subgroup 1		20				
2066	Physical dimensions	---		---	---	---	---
	Subgroup 2		15				
2026	Solderability	---		---	---	---	---
1051	Temperature cycling	Test Cond. C except $T_{(high)}$ = + 140° $^{+3°}_{-0°}$C		---	---	---	---
1056	Thermal shock (glass strain)	Test Cond. B		---	---	---	---
1021	Moisture resistance	No initial conditioning		---	---	---	---
	End-point tests:						
3036	Collector-to-base cutoff current	Bias Cond. D V_{CB} = -25 Vdc I_E = 0		I_{CBO}	---	-1.5	uAdc
3206	Small-signal short-circuit forward-current transfer ratio	V_{CE} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{fe}	15	---	---
	Subgroup 3		15				
2016	Shock	Non-operating Acceleration = 500G 5 blows of 1 msec ea in orientations X1, Y1, Y2, Z1 (total = 20 blows)		---	---	---	---
2056	Vibration, variable frequency	Acceleration = 10 G, min		---	---	---	---
2046	Vibration fatigue	Non-operating Acceleration = 10 G, min		---	---	---	---
2006	Constant acceleration (centrifuge)	G = 10,000 Orientations X1, Y1, Y2, Z1		---	---	---	---
	End-point tests:						
	Same as for Subgroup 2 above						

Table II. Group B inspection-(Cont'd)

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits Min.	Limits Max	Unit
	Subgroup 4		15				
2036	Lead fatigue	Test Cond. E		---	---	---	---
	End-point tests:						
	Same as for Subgroup 2 above						
	Subgroup 5		15				
1041	Salt atmosphere (corrosion)	---		---	---	---	---
	End-point tests:						
	Same as for Subgroup 2 above						
	Subgroup 6		λ=10				
1031	High-temperature life (non-operating)	T_{stg} = +140°C, min		---	---	---	---
	End-point tests:						
3036	Collector-to-base cutoff current	Bias Cond. D V_{CB} = -25 Vdc I_E = 0		I_{CBO}	---	-2.0	uAdc
3206	Small-signal short-circuit forward-current transfer ratio	V_{CE} = -6 Vdc I_E = 1 mAdc f = 1 kc		h_{fe}	12	---	---
	Subgroup 7		λ=10				
1026	Steady-state operation life	V_{CB} = -10 Vdc P_T = 150 mW T_A = + 25° ± 3°C		---	---	---	---
	End-point tests:						
	Same as for Subgroup 6 above						

1/ See 4.3.2 herein.

Table III. Group C inspection. 1/

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD	Symbol	Limits Min.	Limits Max.	Unit
	Subgroup 1		20				
1001	Barometric pressure, reduced (altitude operation):	Pressure = 15 ± 2 mmHg t = 60 sec., min Normal mounting					
3036	Collector-to-base cutoff current	2/ Bias Cond. D V_{CB} = -25 Vdc I_E = 0		I_{CBO}	---	1.0	uAdc

1/ Periodicity: see 4.2 herein.

2/ This test to be performed and measurement made during subjection of the sample units to the reduced pressure specified.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery.- Preparation for delivery shall be in accordance with Specification MIL-S-19500.

6. NOTES

6.1 Notes.- The notes included in Specification MIL-S-19500, with the following exceptions, are applicable to this specification.

6.2 Intended use.- Transistor Type 2N2377 covered herein is designed intentionally to serve current maintenance needs as a direct replacement for Transistor Type 2N495 in existing military equipments. Transistor 2N495, previously available under requirements of Military Specification MIL-T-19500/54(SigC), is no longer being manufactured. It should be noted that Transistor 2N2377 covered herein is more diminutive, dimensionally, than former Transistor 2N495. It should be noted further, that, for maintenance-replacement purposes in existing military equipments, Transistor 2N2377 is more readily adaptable to use in limited-space circuitry than the available equivalent but larger-dimensioned Transistor Type JAN-2N1118 that is covered by Military Specification MIL-S-19500/138.

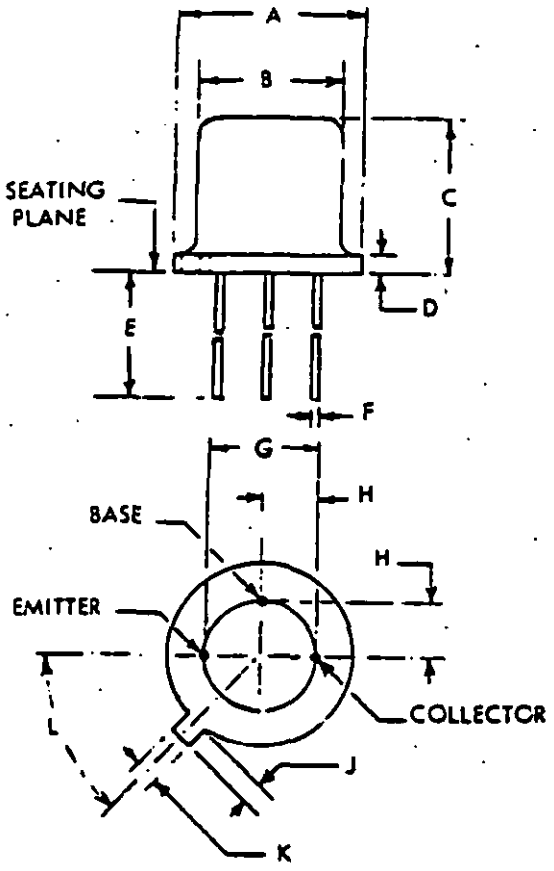
6.3 Re-evaluation or verification inspection.- The LTPD method is exceptionally well suited for inspection at source, since it provides a high degree of assurance (90% confidence) that the lot represented has a proportion defective less than the specified LTPD value. However, the LTPD method is not suitable for inspection performed subsequent to source inspection since it provides, at most, a 10% confidence that the lot represented by a failed sample actually contains a proportion defective in excess of the specified LTPD value. As a result, whenever the quality of a lot is re-evaluated or verified by sampling inspection subsequent to the supplier's satisfactory demonstrations of compliance with the quality requirements, lot disposition should be based on a sampling plan which provides reasonable assurance that any lot rejected contains a proportion defective greater than the specified LTPD or λ value for any individual subgroup. When deemed necessary, the purchase order should specify the detailed criteria for lot disposition.

6.4 Qualification.- With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List (QPL)-19500, supplement (Army), whether or not such products have actually been so listed by that date. Information pertaining to qualification of products covered by this specification should be requested from the Chief, Specification Engineering Division, U.S. Army Electronics Materiel Support Agency, Fort Monmouth, New Jersey, ATTN: SELMS-PPM-3.

Custodian:
Army - EL

Preparing activity:
Army - EL

Project No. 5960-A470



REF.	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.209	.230	5.31	5.84	
B	.178	.195	4.52	4.95	
C	.170	.210	4.32	5.33	
D		.030		0.76	
E	.500		12.70		
F	.016	.019	0.41	0.48	1
G	.100		2.54		
H	.050		1.27		2
J	.028	.048	0.71	1.22	
K	.036	.046	0.91	1.17	
L	45°		45°		2

NOTES:

1. The specified lead diameter (3 leads) applies to the zone between .050 and .250 below seating plane. Between .250 from seating plane, and end of lead, a maximum of .021 shall be held.
2. As measured with a suitable gage at a gaging plane .054 $^{+.001}_{-.000}$ below seating plane, the lead orientation shall be within .007 of specified locations relative to true orientation of tab (centerline). When gage is not used, measurement shall be made at seating plane.
3. All terminals insulated from case.

Figure 1. Outline and dimensions.

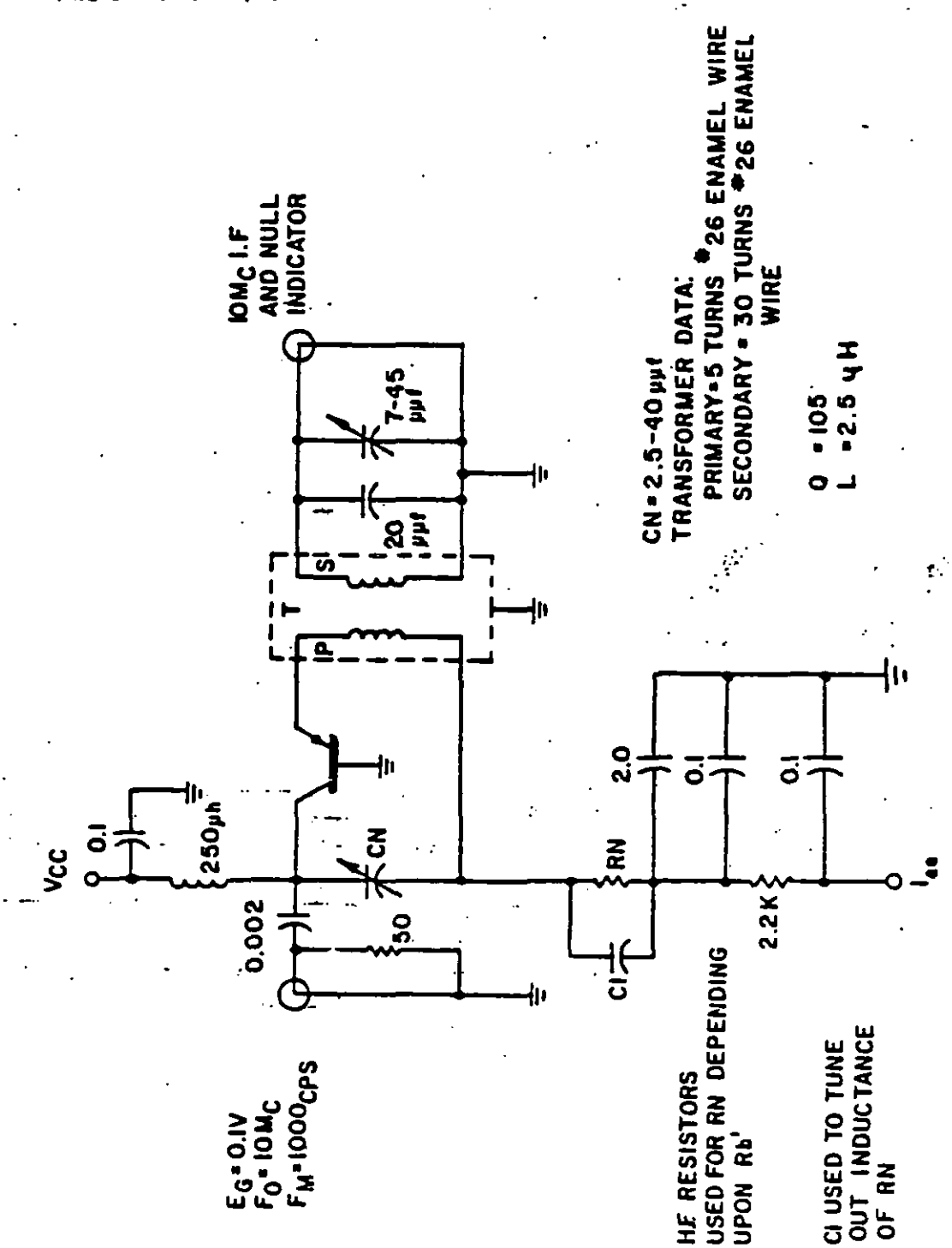


Figure 2. R_b'/C_c test circuit.

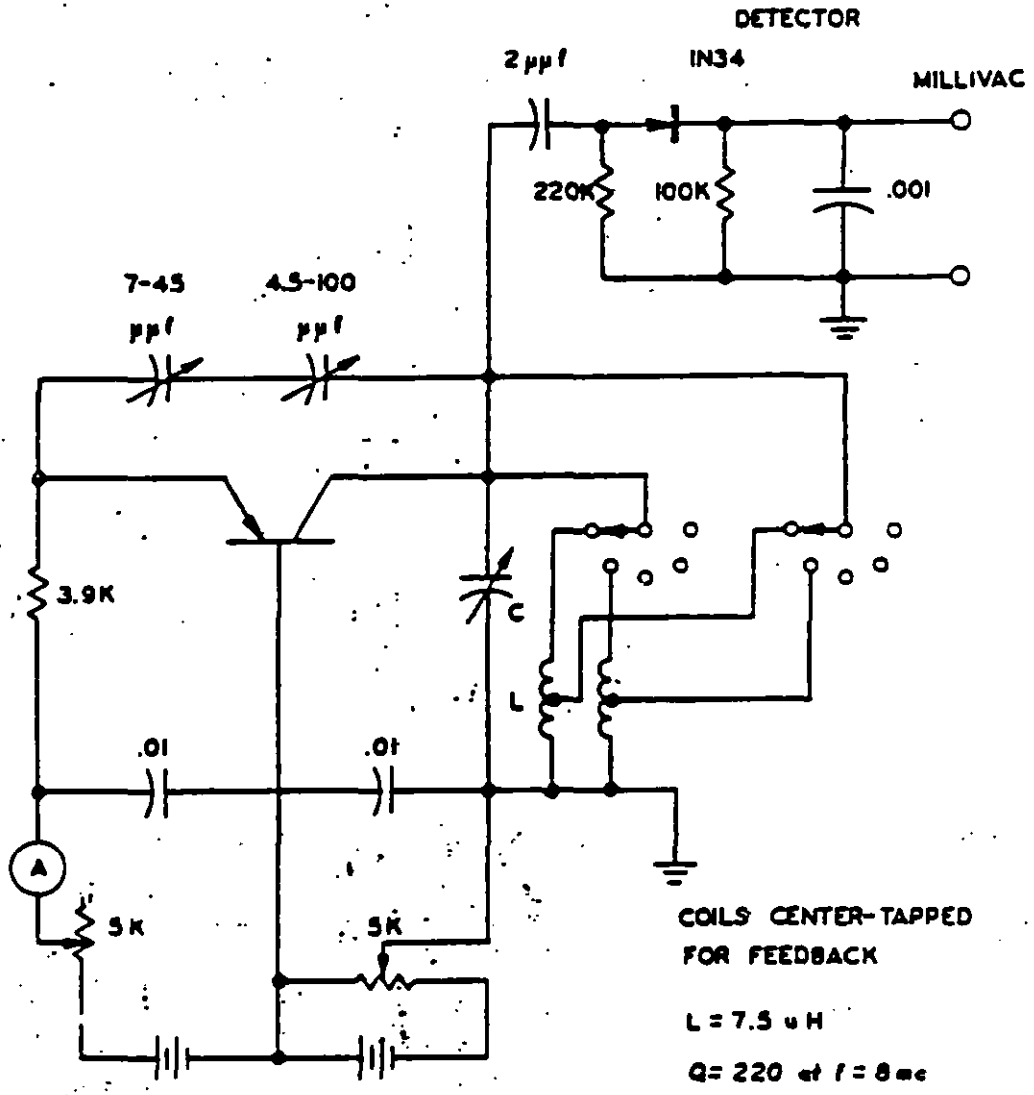


Figure 3. $E_{(dc\,out)}$ test circuit.